ISSN 2543-506X

Cognitive Science – New Media – Education | Vol. 4 [1/2018]

DOI: http://dx.doi.org/10.12775/CSNME.2018.006
Received: May 30, 2018 / Accepted: a) December 6, 2018; b) July 19, 2018

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Open Educational Resources in Subject Education – Chemistry, Case Study

Abstract. In the face of media development, for today's generation of students, the internet is a natural life environment. The provision of peer-reviewed educational materials based on the principle of free licenses allows students to search for materials that are in line with today's knowledge, and it is permitted for anyone to modify these materials.The paper presents an overview of open resources that can be used in teaching chemistry in the context of the division into licenses.

Keywords: open educational resources; chemistry; free licenses; online textbooks; e-books; iTunesU; open lessons

Introduction

"The idea of open education is based on the belief that the knowledge of the whole world is a public good, therefore everyone should be allowed to use, adapt to their needs, improve and distribute educational materials without restrictions, in order to make education both a more accessible and more effective tool" (Grodecka, Śliwowski, 2012, p. 7).

For the first time the term Open Educational Resources (OER) was used in 2002, during the UNESCO *Forum on the Impact of the Open Courseware for Higher Education in Developing Countries*, which participants recognized the need to create public educational resources. "Open Educational Resources (OER) are defined as materials that are publicly avail-

able on the Internet (without access control), published with the right to further use (for this purpose it is recommended to use the so-called free licenses) and most often developed in an open manner" (Koalicja Otwartej Edukacji, 2010, p. 5). Therefore OER are widely available and free materials (e.g. textbooks, online courses, syllabus, tests, multimedia and tools used in the teaching and learning process), which can be further used, adapted, corrected, or translated to other languages without having to ask the author for permission. OER are content published under the terms of free licenses or materials that have been transferred to the public domain.

The subject of Open Educational Resources is particularly important for teachers, students and their parents who not only face dilemmas related to copyright. Research shows that the use and processing (reuse) of open resources increases the prestige of teachers as the authors of educational materials, supports their professional development and increases their commitment to work (OER Evidence Report 2013–2014, p. 21). Students gain the opportunity to learn from a larger database of materials and what is important, open educational resources lead to a change in the teaching structure – from teaching based on learning content to teaching based on content production and changing the role of a passive student into an active one (D. Orr, M. Rimini, D. Van Damme, 2015, p. 16). Parents can recommend children to use open educational resources, such as online courses, applications, tutorials or instructional videos.

Copyleft and Creative Commons

A free license is a type of contract that the author of the work, the owner of copyright, concludes with the rest of humanity (Grodecka, Śliwowski, 2012, p. 14). Free licences (Figure 1) allows:

- re-use of materials developed by others;
- changing, transforming, adapting the content to your goals and needs (e.g. translating into a foreign language);
- combining different materials (e.g. text with image or text with sound);
- re-distribution, that is, sharing your work with others (Gurel, 2008).

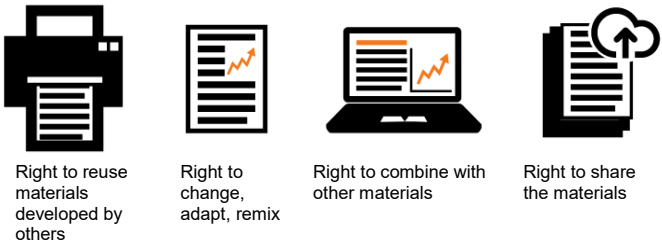

Figure 1. Creative Commons licenses rights (Moraczewska, Haratyk, 2012, p. 14).

Creative Commons licenses (CC) are a type of contract under which the creator makes his work available under certain conditions. Replacing the "all rights reserved" principle with "certain reserved rights", CC licenses are the most popular free licenses used for licensing content other than software (Figure 2). However, not all CC licenses are fully free. Of the six existing licenses, only two are fully free:

- Creative Commons Attribution 3.0 (CC-BY),
- Creative Commons Uznanie Attribution-ShareAlike 3.0. (CC-BY-SA).

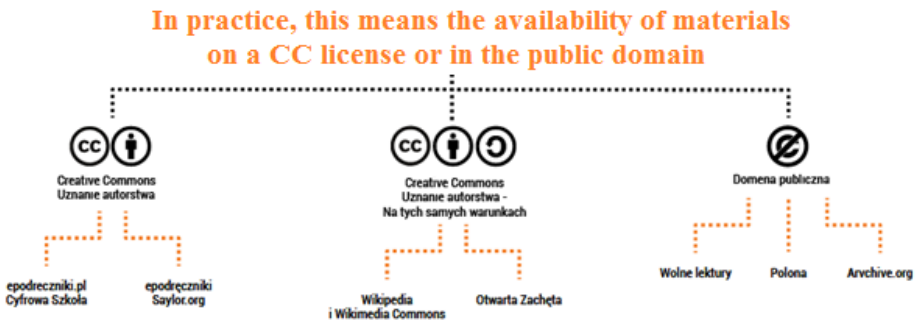

Figure 2. Creative Commons licenses rights and examples of materials (Moraczewska, Haratyk, 2012, p. 14).

E-books project for general education

Data from the Central Statistical Office indicate that in 2018 Internet access had 84.2% of households and 99.2% of households with children (94.6% of households with children already had at least one computer in 2012). Therefore, there is no doubt that the network is a place where students look for information, inspiration and where they exchange messages. On the internet important scientific publications, scripts, courses, lectures, works and collections of art, illustrations, photographs, e-books can be found. Internet used in a thoughtful way may be a valuable help for students and teachers (D. Siemieniecka, p. 117). Therefore, the project "e-books for general education" created as part of the "Digital School" program prepared by the Ministry of National Education is a response to the needs of students and the challenges of a modern digital school. As part of the project, a modern educational platform was created, order to develop and share e-books on the principles of full openness (materials are published under free licenses). E-books were created to supplement the paper textbooks received by the student, not to replace them. They should be additional didactic help.

Chemistry, World Through A Looking Glass

All materials contained in e-books, i.e. texts, illustrations, film materials, are available under the Creative Commons License Attribution 3.0 (CC-BY) Poland or on the principle of "fair use", which means that you can use such materials, inter alia, for educational purposes. Therefore, such resources can be copied, modified and new materials may be created on their basis (also for commercial use). Attribution means that the used material should be appropriately marked (its author shall be provided) along with a link to the license and indications if any changes to the material have been made.

Figure 3. Page from e-book Chemistry, World Through A Looking Glass (*Source: Author's archive*)

After selecting the appropriate module (lesson), the tabs are available in the upper bar (Figure 3):

- core curriculum (1) – activation of this function allows displaying information about the presented educational content in relation to the currently applicable core curriculum; the description consists of the title of the e-book, the level of education and a detailed description of the skills defined by the core curriculum for the e-book text currently being viewed;
- licenses (2) – activation of this function allows displaying detailed information about licenses for presented contents and its authors;
- object licenses (3) – enable / disable the display option in the e-book details of the license for each multi-format multimedia and interactive object (WOMI);
- additional descriptions (4) – activating this function allows displaying descriptions of multimedia materials, e.g. an exact description of what is visible in the film sequence; this function can be very helpful for people with vision disability;
- contact (5) – displaying a contact form allowing each user to report an error by email, express an opinion, and submit a new idea regarding the functionality of the platform.

Licenses for objects are additionally marked with materials such as illustrations, photos and film sequences (Fig. 4).

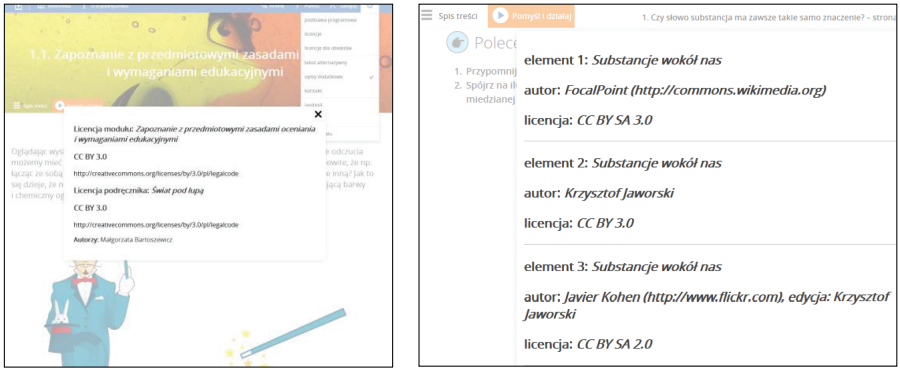

Figure 4. E-book illustration license Chemistry, World Through A Looking Glass (*Source: Author's archive*)

Additional contents (1) that go beyond the core curriculum of general education in the platform's resources have been marked with an asterisk icon, and the methodical frame (2) dedicated to the teacher with the icon of the cap (Figure 5). In order to take advantage of all available options offered by the www.epodreczniki.pl platform, you must log in to it. To do this, complete the registration form and send it. Successful completion of the registration process follows clicking the activation link. Working with the e-book is possible in two modes: student (3) or teacher (4) (epodreczniki.pl, 2015).

Figure 5. E-book Chemistry, World Through A Looking Glass home page (*Source: Author's archive*)

Fixed elements of the content of individual modules (lessons), the purpose of which is to make students interested in the natural sciences are:

1. **Lead** – the first paragraph of the text binding the content of the lesson with the student's personal experience (Fig. 6)

Figure 6. E-book Chemistry, World Through A Looking Glass Lead
(*Source: Author's archive*)

Lead functions:

- Making student curious, presenting the issue as a fascinating and worth knowing thing;
- A reference to the student's personal experiences;
- A reference to knowledge gained from previous lessons.

2. **Multimedia** – illustrations, photos, videos, animations, galleries, slide shows (Fig. 7)

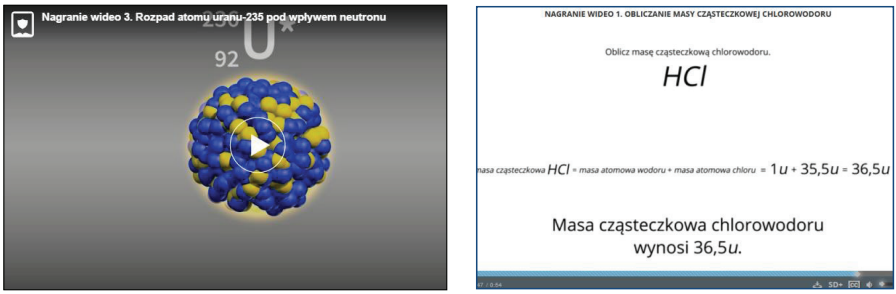

Figure 7. E-book Chemistry, World Through A Looking Glass video
(*Source: Author's archive*)

3. **Extra content** addressed to students interested in the subject (Fig. 8)

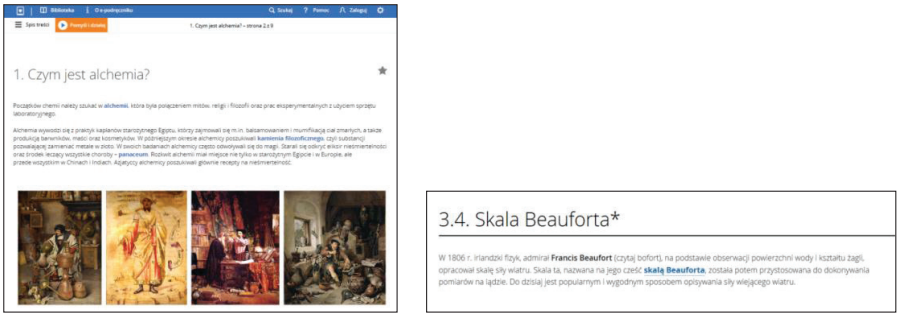

Figure 8. E-book Chemistry, World Through A Looking Glass Extra content
(*Source: Author's archive*)

4. **Fun facts:**
   - Short text related to the content of the issue containing information about interesting facts;
   - Sometimes it helps to understand the content of the problem or supplements it;
   - Knowledge of the text is not necessary to fully understand the issue (Fig. 9).

Figure 9. E-book Chemistry, World Through A Looking Glass Extra fun facts
(*Source: Author's archive*)

Additionally, within the modules (lessons) tasks, interactive exercises with verification of the correctness of the answers are available, as well

as proposals of experiments for independent implementation – *Think and do* (Bartoszewicz, Karawajczyk, 2015, Bartoszewicz, Szczepaniec, Wojewoda, 2015). Selected fragments of the e-book can be used by the teacher as a material enriching lessons, illustrating issues difficult for students, e.g. film sequences explaining the selection of chemical reaction coefficients or creating names of chemical compounds.

Moreover, supplementary materials were also created for teachers – methodical and didactic resources: curricula, lesson plans, tutorials for teachers and a collection of school books (Bartoszewicz, Karawajczyk, Kamińska-Ostęp, 2015).

iTunes U – OPEN LESSONS

iTunes U is the world's largest library of free educational content, containing lectures from well-known universities, libraries, museums and courses prepared by teachers of each educational level. iTunes U is a public educational platform that anyone who wants to study at can use, regardless of age.

On the iTunesU platform a social project Open Lessons was created by teachers who want to share their knowledge and experience in conducting classes using new technologies.

Each of the offered courses has specific educational goals and a framework set up during the meetings of the team of teachers of various subjects who initiated the project. They are focused on the comprehensive development and active work of the student through the use of a variety of resources: photos, illustrations, digital: film sequences, interactive exercises and tasks, e-books.

On the website www.otwartelekcje.org you can find information about the project, and on the platform iTunes U, a database of model courses divided into thematic categories was made available. One of such courses is Chocolate chemistry (Fig. 10) (Bartoszewicz, Grześko, 2016). Open Lessons is a project based on the idea of Sharing Education. Both individual teachers interested in creating iTunes U courses and schools can participate in the project. In the first year of the implementation of the project, over 100 courses were available under the open license (Plebańska, 2017).

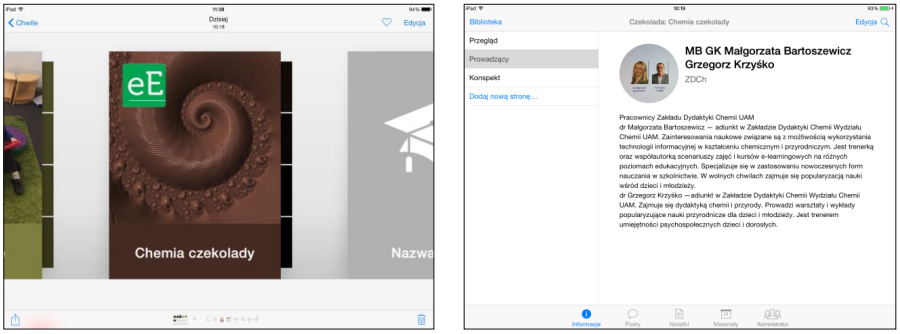

Figure 10. Open lessons – Chocolate chemistry (*Source: Author's archive*)

PhET simulations

In natural sciences, simple simulations facilitate the understanding of phenomena and processes. One of the very useful applets are the PhET interactive simulations designed by the University of Colorado Boulder. Simulations are available on the website http://phet.colorado.edu (Fig. 11) and made available as open educational resources under license Creative Commons Attribution (CC-BY).

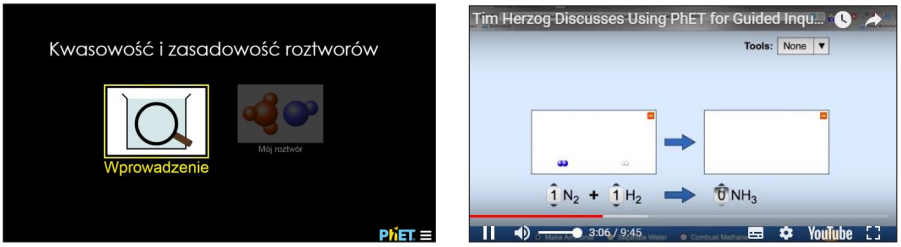

Figure 11. Saylor Academy (*Source: https://phet.colorado.edu/en/simulations/category/chemistry – Author's archive*)

The portal also contains resources dedicated to teachers, for example tips on the use of Phet simulation in the classroom, where during a short film sequence university lecturer, professor of chemistry, discusses ways

to apply the prepared materials depending on the level of education and material.

Saylor Academy

One of the examples of English-language courses available on a free license basis is the Saylor Academy project (Figure 12). The developed materials are available under the Creative Commons Attribution 4.0 license. Which means that the content can be freely:

- shared – copy and distribute material;
- adapted – change, correct, modify the work for any purpose, even commercial.

However, the authorship of the material shall be recognized.

Figure 12. Saylor Academy (*Source: saylor.org – Author's archive*)

Saylor Academy courses are subject to certification at an additional charge. Therefore, the free license does not cover the question banks and the final exams. Individual exam attempts are not licensed for re-use and may not be copied, adapted, published or disseminated without permission. Third party materials are protected by the copyright of their owners and are available under various licenses. Basic chemistry course (Figure 13).

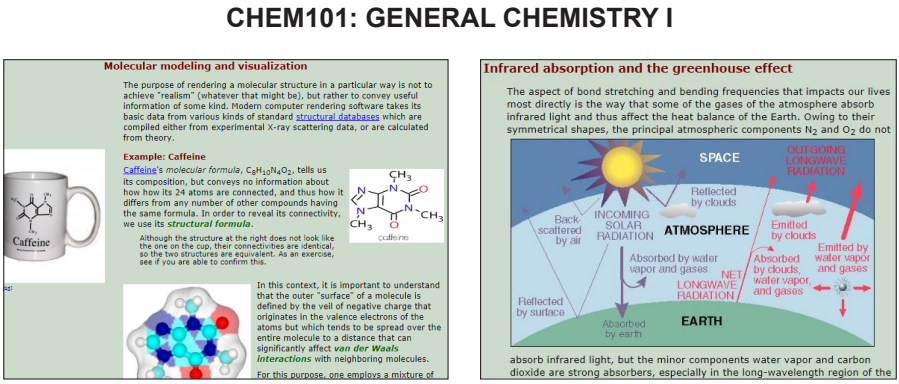

Figure 13. Saylor Academy *General chemistry* (*Source: http://www.chem1.com – Author's archive*)

Summary

The abovementioned internet resources do not exhaust the topic, it should be mentioned in the context of chemical education about projects, scholaris.pl portal, or even the didactic tool base of the Educational Research Institute (IBE) or the Khan Academy project. The article mainly focuses on the content available in Polish, because they prefer teachers, indicating that it is easier for them to refer to the core curriculum of chemistry that they implement. In the world, the creation of open educational resources is common, and universities create special courses aimed at a wide audience, not just students. This trend can be observed with us, for example, the Knowledge Development Education Operational Program (POWER), the third priority – co-financing the creation of open educational resources at universities.

According to UNESCO, open educational resources support the implementation of one of the most important goals of sustainable development in the area of education, namely ensuring integration and equal access to high quality education and lifelong learning opportunities (Creative Commons Polska, 2016).

Today junior high school students or 7–8 elementary school pupils are young people who do not know the world without electronic media and information technologies. Called the generation of "digital natives" in a natural way they can easily resist the world of computers, video

games and the Internet; they like multitasking, they work best on the principles of networking, they prefer free and quick access to information (Prensky 2001).

Thus, the idea that accompanies the creation and sharing of open materials is the willingness to share their knowledge with others, as well as the feeling that knowledge is a common property. It can therefore be said that at the heart of thinking about open educational resources lies the vision of humanity with broad access to materials that facilitate education and development. Knowledge is a shared property that everyone should be able to use and be able to spread, improve and publish changes for the benefit of the entire community. Activities related to the opening of educational resources aim at disseminating education itself, limiting the barriers to access to content, and thus equalizing social opportunities and promoting creative use of educational resources (http://www.nina.gov.pl/baza-wiedzy/otwarte-zasoby-edukacja-dla-wszystkich/).

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